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The Prevalence of Self-Monitoring of Blood Glucose and Costs of Glucometer Strips in a Nationwide Cohort

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Abstract

Objective: This study used nationwide data to determine the prevalence of self-monitoring of blood glucose (SMBG) among all non-institutionalized persons living in Norway and to estimate the prevalence of SMBG among diabetes patients, the frequency and cost of SMBG, and the use of different glucometers.

Methods: This retrospective, descriptive study is based on data of sales of glucometer strips to non-institutionalized persons in Norway in 2008. The data included gender, age group, month of purchase, sales place, type of strips, number of packages dispensed, and cost of strips. Additionally, statistics on sales of insulin and oral antidiabetes medications were obtained from the Norwegian Prescription Database.

Results: A total of 96,999 persons purchased strips, a prevalence of 2%. Approximately 70% of diabetes patients practiced SMBG. An average patient used 1.7 strips per day, and younger patients purchased more strips than older patients. Fewer than 50% of patients performed glucose measurements daily. One percent of patients used more than 10 strips daily and was accountable for 8% of total costs. Most patients used only one type of strips, but the number of strips purchased increased with the number of different strips. The average annual cost of strips was 446 € per person.

Conclusions: Two percent of all non-institutionalized inhabitants and an estimated 70% of patients using diabetes medication purchased SMBG strips. A small percentage of the patients incurred a substantial proportion of the costs. This, along with the fact that over half of the patients monitor less than once per day, calls for tighter follow-up of diabetes patients.

Introduction

AFTER THE DIABETES CONTROL and Complications Trial¹ and the United Kingdom Prospective Diabetes Study² showed the benefits of stringent glucose control for both patients with type 1¹ and type 2² diabetes, self-monitoring of blood glucose (SMBG) has been widely recommended by patient and professional organizations as an integral part of the management of diabetes.^{3–5} However, few studies have investigated the extent and costs of diabetes patients' use of SMBG in their day-to-day management of diabetes.^{6–8}

Worldwide annual cost of SMBG is estimated to be over \$5 billion US, with a yearly growth rate of 11.5%.⁹ Neither prevalence of SMBG nor frequency of measurements is widely studied. Published work often consists of small-scale studies of selected patient groups (e.g., patients with type 1 diabetes,⁶ seniors in Nova Scotia⁷), and thus the findings are difficult to

extrapolate to entire populations of diabetes patients. One notable exception is a study performed by the National Center for Chronic Disease Prevention and Health Promotion in North America, using random-digit-dialed telephone survey of the non-institutionalized, U.S. civilian population aged > 18 years to investigate the rate of patients with diabetes who performed SMBG at least once per day. It found that in 2006 the daily SMBG rate was 63.4% among all adults with diabetes and 86.7% among those treated with insulin.⁸

There generally seems to be agreement among researchers, clinicians, and patient organizations that all patients who use insulin should perform SMBG,^{8–10} but there is not agreement on whether patients not using insulin benefit from SMBG at all.^{11–16} Also, it is difficult to define limits for under- or overconsumption of strips, or to define what the "correct" frequency of measurement should be, as most guidelines are vague on these issues, especially regarding patients who do

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TABLE 1. NUMBER OF PATIENTS AND AVERAGE NUMBER OF STRIPS BOUGHT PER PERSON PER DAY BY AGE GROUP AND GENDER

Age group (years)	Gender	Number of patients	Number of strips per day per person ^a
Under 15	Female	907	6.5 (6.2–6.7)
	Male	950	6.5 (6.2–6.7)
15–29	Female	2,462	3.0 (2.9–3.2)
	Male	2,421	3.0 (2.9–3.2)
30–44	Female	5,691	2.3 (2.2–2.4)
	Male	6,057	2.3 (2.2–2.4)
45–59	Female	9,992	1.7 (1.7–1.8)
	Male	13,794	1.6 (1.5–1.6)
60–74	Female	15,326	1.4 (1.4–1.4)
	Male	19,073	1.3 (1.3–1.3)
75 or older	Female	11,360	1.2 (1.1–1.2)
	Male	8,966	1.1 (1.1–1.1)
Total		96,999	1.66 (1.65–1.68)

^aMean (95% confidence interval).

not use insulin.⁵ Bergenstal and Gavin¹⁰ have published guidelines on behalf of the Global Consensus Conference on Glucose Monitoring Panel that specify different frequencies depending on how well the patient's blood glucose is regulated and the patient's use of medication, but the evidence underlying these recommendations is not strong, and the newly published Norwegian diabetes guideline⁴ does not suggest a recommended frequency of measurement.

The aim of this study was to use complete nationwide data to determine the prevalence of SMBG among all non-institutionalized persons living in Norway. Furthermore, we wished to estimate the prevalence of SMBG among diabetes patients, the frequency and cost of SMBG, and the use of different glucometers.

Subjects and Methods

All Norwegian residents and persons employed and working in Norway are compulsorily ensured under the National Insurance Scheme, funded through national tax systems. This covers certain prescribed medication and medical supplies for patients suffering from chronic illnesses such as diabetes. All reimbursed sales of blood glucose strips in Norway are reported to The Norwegian Health Economics Administration (HELFO), a subordinate institution directly linked to the Norwegian Directorate of Health.¹⁷

We received data from HELFO on all instances where individual patients had prescriptions dispensed on strips in 2008. The variables included gender, age group (under 15, 15–29, 30–44, 45–59, 60–74, and 75 years or older), sales place, month of purchase, type and number of strips purchased, and cost of strips. HELFO replaced personal identification numbers with an anonymous ID code, so that each individual's purchase pattern could be traced.

Furthermore, we extracted national data on sales of insulin and oral antidiabetes medications from the Norwegian Prescription Database (NorPD) at the Norwegian Institute of Public Health,¹⁸ with the following variables: ATC code (A10A [insulin and analogs] and/or A10B [blood glucose-lowering drugs except insulins]), age group (10-year intervals), gender, number of users, number of users per 1,000 inhabitants, and costs.

Strips bought by hospitals or nursing homes are excluded from both the data from HELFO and from NorPD. Statistical analysis was performed using SPSS version 15 (SPSS, Inc., Chicago, IL) or Microsoft (Redmond, WA) Excel. One-way analysis of variance was used to compare means.

Results

A total of 96,999 different patients collected strips in Norway in 2008, i.e., 2% of the Norwegian population. Only 2% of strips were purchased outside of pharmacies. There was a small but significant gender difference in the average daily

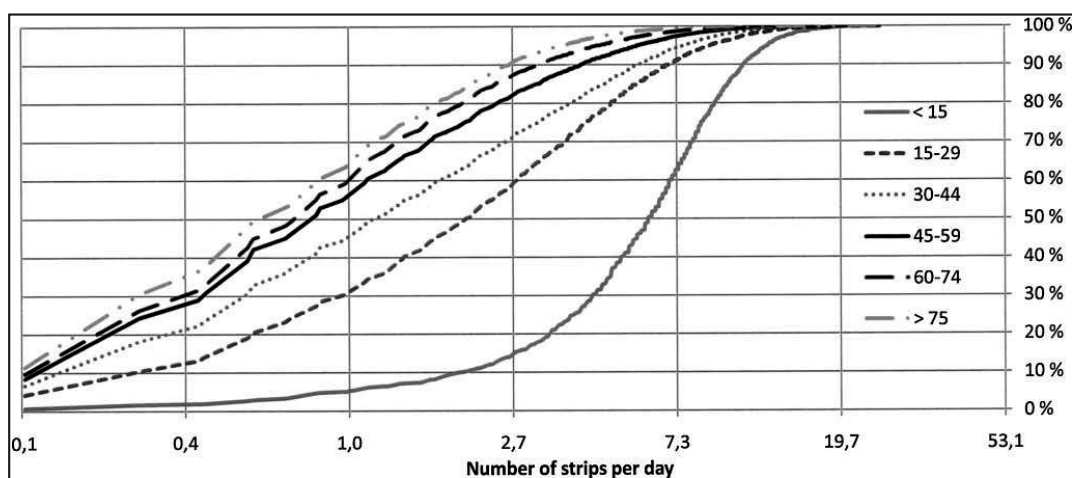


FIG. 1. Cumulative numbers of persons buying strips in each age group by number of strips per person per day.

use of strips. Women used on average of 1.71 strips per day (confidence interval [CI] = 1.69–1.74), and men used on average 1.62 strips per day (CI = 1.60–1.64). Younger patients purchased significantly more strips than older patients (Table 1) (one-way analysis of variance, $P < 0.001$).

Of all the patients in our study, 45% purchased enough strips to monitor glucose daily. Among patients under 30 years old, 77% purchased enough strips for daily SMBG. Figure 1 shows the cumulative percentage of patients for each age group. One percent of the patients used more than 10 strips per day, incurring 8% of the total costs, and 272 people bought more than 5,000 strips (i.e., 100 packages of 50 strips) in 2008.

Table 2 shows the number of patients who purchased blood glucose strips compared to the number of patients taking insulin, oral antidiabetes drugs (OADs), and insulin and/or OADs and the corresponding costs per group. A total of 138,749 individuals purchased insulin and/or OADs in 2008, corresponding to 2.9% of the population. Thus, if we exclude patients being treated nonpharmacologically for their diabetes and assume that all patients who receive reimbursement for SMBG have diabetes, in average 70% of patients using insulin and/or OADs were practicing SMBG. In the under 30 years age group, 85% of the number of patients who purchased insulin and/or OADs purchased strips. However, of the patients using OADs, 1,226 of 1,486 were women, and it is likely that this large gender difference can be explained by the fact that metformin (the OAD used by 98% of these women) is also used in the treatment of polycystic ovary syndrome. If one attributes the difference in prevalence between men and women to this and extracts it from the total number of patients treated with insulin and/or OADs, 97% of diabetes patients under the age of 30 years perform SMBG. In total, 43,250,681 € was spent on glucometer strips, 41,081,316 € on insulin, and 14,525,420 € on OADs.

In 2008 there were four main manufacturers providing glucometers for the Norwegian market, and the sale was distributed among 13 different types of reimbursable strips. Roche (Basel, Switzerland) and Bayer Diabetes Care (Leverkusen, Germany) each covered 36% of the market, Abbott Diabetes Care (Abbott Park, IL) 18%, and LifeScan (Milpitas, CA) 10%. The majority of the users (82.3%) bought only one type of strips, and the average number of strips used per day increased with number of different types of strips (Table 3) (one-way analysis of variance, $P < 0.001$).

Discussion

Prevalence and frequency of SMBG

To our knowledge this is the first study to investigate the use of strips by recording all sales of strips in a country. Other studies investigating occurrence of SMBG have used patient interviews or questionnaires on selected population samples.^{6,7,19} The prevalence of SMBG in our population was 2%. Unfortunately, we do not have data on whether the patients have type 1 diabetes or type 2 diabetes, nor do we know if a specific patient uses insulin and/or OAD, but using the data from the NorPD we can estimate that 70% of patients with diabetes practice SMBG. In the under 30 years age group we assume that the majority have insulin-dependent diabetes, and this is confirmed by studying the data from NorPD.¹⁸ It is likely that the majority of the patients in this age group who use insulin also practice SMBG, while the majority of patients

TABLE 2. NUMBER OF PERSONS WHO PURCHASED STRIPS, INSULIN, OR ORAL ANTIDIABETES DRUGS, BY AGE GROUP

Age group (years)	Strips			Insulin			OAD			Insulin and/or OAD		
	Number of patients	Patients/1,000 inhabitants	Sum paid per patient ^a	Number of patients	Patients/1,000 inhabitants	Sum paid per patient ^a	Number of patients	Patients/1,000 inhabitants	Sum paid per patient ^a	Number of patients	Patients/1,000 inhabitants	Sum paid per patient ^a
0–29	6,740	3.8	1,066.5	6,569	3.7	922.4	1,486	0.8	49.2	7,898	4.4	776.4
30–59	35,534	18	494.1	20,354	10	876.4	34,586	18	147.5	48,990	25	468.2
60+	54,725	54	338.2	24,048	24	714.7	69,116	68	135.3	81,861	81	324.2
Total	96,999	20	445.9	50,971	11	806.0	105,188	22	138.1	138,749	29	400.8

OAD, oral antidiabetes drug.

^aSums given in Euros.

TABLE 3. USE OF DIFFERENT TYPES OF SELF-MONITORING OF BLOOD GLUCOSE STRIPS BY NUMBER OF PATIENTS AND MEAN NUMBER OF STRIPS USED PER DAY

Number of different types of strips	Number of patients (%)	Mean number of strips per day
1	79,837 (82)	1.4
2	14,571 (15)	2.8
3	2,171 (2.2)	4.5
4	343 (0.4)	6.4
5	62 (0.1)	7.2
6	14 (0.0)	9.5
7	1 (0.0)	7.0

using OAD are women being treated for polycystic ovary syndrome with metformin, which does not require SMBG. OADs other than metformin could be used for indications other than diabetes, such as thiazolidinediones for fatty liver and exenatide for weight loss, but as diabetes is the only recorded indication for these drugs in Norway we assume that any effect of this on our results is negligible. Among the patients in our study who are under 30 years old, 77% purchase enough strips to monitor glucose daily. Among insulin users in a North American study, 86.7% of patients over 18 years old performed SMBG at least once per day.⁸

Of all the patients in our study only 45% purchased enough strips to measure blood glucose at least once daily, and 10% purchased only one package (50 strips) per year. However, the true percentage of patients who practiced daily SMBG may be even lower because patients did not necessarily use all the strips they purchased. Thus frequency of SMBG is low compared to the results of the North American study from 2006 where the daily SMBG rate was 63.4% among all adults with diabetes.⁸ A cross-sectional Danish-British multicenter survey from 1999–2000 showed that SMBG was performed daily by 39% of patients with type 1 diabetes and less than weekly by 24%,⁶ while Hanko et al.¹⁹ studied patients with type 2 diabetes visiting 14 Hungarian pharmacies in the spring of 2004 and found that 43.6% of the patients did not practice SMBG at all and 81% of the patients who did practice SMBG did so less than once per day. The guidelines of Bergenstal and Gavin¹⁰ recommend SMBG from one or more times daily for patients taking oral agents alone to three or more measurements per day for patients receiving multiple daily insulin injections or using an insulin pump.

Our finding that 1% (approximately 1,000 patients) purchase enough strips to measure their blood glucose 10 times or more every day throughout the entire year indicates overconsumption, or at least overpurchasing, of glucometer strips. Reasons for frequent measurements may include truly poor glycemic control, that the patients feel insecure and perform SMBG “just to check,” or poor training in correct use of SMBG, and these patients should receive better follow-up. They may need medication adjustment or further training in performing SMBG and use of SMBG results. Individual or joint efforts from general practitioners, diabetes nurses, and/or pharmacists are alternatives to be considered as well as training and information through diabetes patients’ organizations.

Approximately 270 patients purchased more than 5,000 strips in 1 year, equivalent to 100 packages, i.e., 14 strips per day. One cannot exclude that these patients may share strips with others or sell them nationally or internationally. Alternatively, the sales place may enter false sales on their own or in cooperation with general practitioners in order to falsely claim reimbursement.^{20,21} While we assume that this is not common, the costs for these 270 patients add up to almost 1.3 million € for one year, or roughly 4,800 € per person, 10 times the average costs per person. Systematic approaches to “high-cost” patients directly from HELFO, through the patients’ general practitioners, might be an option to address excessive use of strips. Also, the general practitioners writing prescriptions should indicate a maximum number of strips on each prescription rather than writing “for 1 year’s use” as is often the case today. If the patient should need more than this amount he would have to return to his general practitioner for follow-up, and any misunderstandings or problems could be identified.

Changing glucometers

While glucometer strips are reimbursed by the National Insurance Scheme, the glucometers themselves are not. However, it is common practice for the manufacturers to charge a token amount of money or give them away for free. This has led to some concern among health professionals that patients use many different glucometers or change glucometers frequently. Both because of systematic deviations between glucometers and more possibilities for user errors, it may be unfortunate if a patient uses different glucometers simultaneously, especially if these are not the same type of meter.²² In our study we found that 18% of patients bought more than one type of strips, but we cannot tell from our data if this is because the patients changed their glucometer or if they used several instruments simultaneously. However, we can see that those who buy different types of strips purchase more strips. At least some of these patients would most likely also benefit from counseling on their use of SMBG, performed by general practitioners, diabetes nurses or at the pharmacies where they purchase their strips.

Conclusions

The prevalence of SMBG in the non-institutionalized Norwegian population was 2%, while approximately 70% of diabetes patients purchased strips. More than half of the patients do not adhere to the international recommendation¹⁰ of performing SMBG at least once per day. The average annual cost of strips was 446 € per person. The 1% of patients who have the highest purchase of strips are responsible for 8% of the costs. Most patients use only one type of strips, but the number of purchased strips increased with the number of different strips.

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Author Disclosure Statement

None of the authors has any commercial associations that might create a conflict of interest.

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